

1 **METHOD OF USING HIGH TEMPERATURE PLASMA TO**
2 **DISINTEGRATE WASTE CONTAINING TITANYL**
3 **PHTHALOCYANINE**

4 BACKGROUND OF THE INVENTION

5 1. Field of the Invention

6 The present invention relates to a method of using high temperature
7 plasma to neutralize toxic or hazardous material, and more particularly to a
8 method of using high temperature plasma to disintegrate organic
9 photo-conductor material waste containing titanyl phthalocyanine (TiOPc) to
10 non-toxic and non-hazardous materials.

11 2. Description of Related Art

12 Plasma is a highly ionized and high temperature gas, is a combination of
13 molecules, atoms, electrons and positive ions and is considered to be a “fourth
14 state of matter” in addition to solid, liquid, and gas. High temperature plasma is a
15 clean thermal-source that disintegrates large molecules without combustion. The
16 disintegration of the waste is a process involving energy transmission and
17 conversion. Compounds subjected to the high temperature plasma disintegrate,
18 and energy of the compounds in the plasma is transmitted to the waste within
19 electric arcs in the high temperature plasma. When the waste and high
20 temperature plasma interact, electrons in the molecules and atoms of the waste
21 are stripped away from the nucleus of the atoms, break the bonds between atoms
22 of the waste compounds and fundamentally completely destroy the waste.
23 Ideally, using high temperature plasma to break down waste only generates some
24 simple molecules or atoms such as hydrogen atom, carbon oxide, carbon atom,

1 and hydrochloride because the simple molecules or atoms can not recombine
2 into complex molecule in the high temperature plasma.

3 Presently, flammable wastes are treated by incineration. However,
4 incinerating equipment does not completely breakdown the waste and often
5 results in the generation of some toxic products. Consequently, subsequent
6 processes are required to treat the toxic products and are troublesome.
7 Particularly, organic waste of organic photo-conductor (OPC), i.e. titanyl
8 phthalocyanine (TiOPc), cannot be disintegrated by incineration and is classified
9 as nonflammable material. Therefore, organic photo-conductor waste containing
10 titanyl phthalocyanine is a significant waste treatment system problem for
11 manufacturers.

12 To overcome the shortcomings, the present invention provides a method
13 using high temperature plasma to disintegrate waste containing titanyl
14 phthalocyanine (TiOPc) to mitigate or obviate the problems.

15 SUMMARY OF THE INVENTION

16 The main objective of the invention is to provide a method using high
17 temperature plasma to disintegrate waste containing titanyl phthalocyanine
18 completely to simplify subsequent processes in waste treatment systems.

19 Other objects, advantages and novel features of the invention will
20 become more apparent from the following detailed description when taken in
21 conjunction with the accompanying drawings.

22 BRIEF DESCRIPTION OF THE DRAWINGS

23 The patent or application file contains at least one drawing executed in
24 color. Copies of this patent or patent application publication with color drawings

(Figs. 1 and 2) will be provided by the Office upon request and payment of the necessary fee.

Fig. 1 is a color drawing of lava from example 1 (glass: soil: TiOPc=7:10:3) after treatment with high temperature plasma in accordance with the present invention;

Fig. 2 is a color drawing of lava from example 2 (glass: TiOPc=17:3) after treatment with high temperature plasma in accordance with the present invention;

Fig. 3 is an X-Ray Diffractometer (XRD) spectrum of the lava from example 1;

Fig. 4 is an XRD spectrum of the lava from example 2;

Fig. 5 is an (ultraviolet)-(visible light) spectrophotometer spectrum of a standard sample not treated by high temperature plasma;

Fig. 6 is an (ultraviolet)-(visible light) spectrophotometer spectrum of a standard sample of solvents;

Fig. 7 is an (ultraviolet)-(visible light) spectrophotometer spectrum of a standard sample of glass;

Fig. 8 is an (ultraviolet)-(visible light) spectrophotometer spectrum of a standard sample of the lava from example 1; and

Fig. 9 is an (ultraviolet)-(visible light) spectrophotometer spectrum of a standard sample of the lava from example 2.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

A method of using high temperature plasma to disintegrate titanyl phthalocyanine (TiOPc) comprises acts of heating a mixture of titanyl

1 phthalocyanine, selected waste soil and waste glass or other vitreous materials in
2 a plasma and cooling a resultant lava. The mixture is heated in the plasma to a
3 temperature of 1,220°C to 10,000°C. The preferred temperature is from 1,220°C
4 to 1,456°C. The plasma breaks down the titanyl phthalocyanine into simple
5 benign molecules, and the temperature melts the selected waste soil and waste
6 glass or other vitreous materials to a stable molten vitreous lava. The simple
7 benign molecules resulting from the plasma breakdown of the titanyl
8 phthalocyanine are suspended in the stable molten vitreous lava. When the
9 molten vitreous lava cools and solidifies, the simple benign molecules resulting
10 from the plasma breakdown of the titanyl phthalocyanine are encapsulated in the
11 solid vitreous lava. In the examples, the solid vitreous lava after cooling and
12 being removed from the plasma was tested to analyze its structure and determine
13 the level of titanyl phthalocyanine (TiOPc) in the solid vitreous lava.

14 Because using high temperature plasma to treat waste is extremely safe,
15 easily controlled and non-polluting, high temperature plasma can treat various
16 waste much more efficiently than incinerating furnaces. Moreover, final
17 products of high temperature plasma treatment are in forms of lava that is
18 chemically very stable and has a low leaking rate to satisfy strict environmental
19 protection requirements. Several advantages of using high temperature plasma
20 treatment follow.

21 1. High temperature plasma directly acts on the waste so that loss of
22 thermal energy is reduced.

23 2. The high temperature plasma can be selectively generated in a
24 nitrogen or air environment. Consequently, specific chemical reactions can be

carried out, which cannot be achieved in incinerating furnaces. For example, the high temperature plasma efficiently removes and destroys organic waste in an inert atmosphere and easily reduces the metallic oxide to metal in a reducing environment. Therefore, method of using high temperature plasma to disintegrate waste can be applied simultaneously to various types of wastes such as mixed waste containing flammable and nonflammable materials, metallic waste, toxic waste (chloro-biphenyl, dioxin), contaminated soil, organic hydrocarbon waste (such as waste oil, plastic and resin), filtered residue from waste liquid treatment plants, and residue from incinerating furnaces, etc.

3. The waste can be disintegrated completely without any pre-treatment. Therefore, no operator is exposed to the toxic waste, and costs for pre-treatment are eliminated.

4. Exhaust gases in the high temperature plasma system are minimized, and ash is not easily distributed in pipes so cleaning equipment for the exhausting gases is simple.

5. The solid vitreous lava is formed and molded in blocks during the process and does not require a second treatment so the subsequent processes are obviated. Furthermore, the solid vitreous lava is chemically very stable and has a low titanyl phthalocyanine (TiOPc) leakage rate.

To further understand the method of using high temperature plasma in accordance with the present invention, an example follows with reference an appendix containing Figs 1-9.

Examples:

Samples used were composed of titanyl phthalocyanine (TiOPc),

1 selected waste soil and waste glass. A 100 kilowatt high temperature plasma
2 melting furnace having a maximum temperature greater than $10,000^{\circ}\text{C}$ at a
3 center of the heating source and an electrical density greater 1×10^{16} electrons/cm³
4 provided a heating source to heat the samples. The medium of the high
5 temperature plasma was air. The rate the temperature increases rate and the time
6 that the temperature of the melting furnace was maintained were controlled by
7 adjusting direct current and air inflow rate. In this example, the rate the
8 temperature increases was $7^{\circ}\text{C}/\text{min}$. A crucible composed of 10% chromium
9 oxide and 90% aluminum oxide was used to hold the samples. The crucible was
10 rectangular, 6.5cm in length, 6.5cm in width, 17cm deep and 1cm thick. To
11 distribute the temperature evenly in the melting furnace, multiple ventilating
12 holes were defined in a fire-resistant bottom of the melting furnace to exhaust
13 gas through the ventilating holes to an exhaust pipe. Because temperature was
14 measured with a thermocouple attached to an outer periphery of the crucible, the
15 detected temperature was lower than the actual temperature of the samples inside
16 the crucible.

17 After treating the samples in the high temperature melting furnace, the
18 lava was analyzed to define crystallization of the lava by an X-ray diffractometer
19 (XRD, $K\alpha\lambda = 1.5406\text{\AA}$) and was tested to determine the quantity of residual
20 titanyl phthalocyanine (TiOPc) in the solidified lava by ultraviolet-visible light
21 spectrophotometer.

22 The samples were composed of waste glass, waste soil and titanyl
23 phthalocyanine (TiOPc) in different ratios. Example 1 had a ratio of
24 glass:soil:TiOPc of 7:10:3, and example 2 had a ratio of glass:TiOPc of 17:3.

1 The samples were treated at 1,220°C for one hour and heated to 1,456°C until
2 the samples become vitrified in appearance as shown in Figs. 1 and 2. With
3 reference to Figs. 3 and 4, the lava of example 1 and the lava of example 2 were
4 both vitrified.

5 With reference to Fig. 5, a (ultraviolet)-(visible light) spectrophotometer
6 analysis of a standard sample containing titanyl phthalocyanine (TiOPc) not
7 treated with high temperature plasma has a major peak at 692 nm that represents
8 the titanyl phthalocyanine (TiOPc) peak. With reference to Fig. 6, a spectrum of
9 a solvent used in the mixture was obtained as a standard. With reference to Fig. 7,
10 a spectrum of waste glass treated with high temperature plasma was obtained to
11 be used as a standard. The spectrums of example 1 and example 2 were
12 compared with the standards obtain to determine how much titanyl
13 phthalocyanine (TiOPc) was in the solidified lava. With reference to Fig. 6 and 7,
14 no peak exists at 692 nm, which means no titanyl phthalocyanine (TiOPc) is
15 present. In the spectrum of example 1 (Fig. 8) and the spectrum of example 2
16 (Fig. 9), no peak at 692 nm is found either. Therefore, no titanyl phthalocyanine
17 (TiOPc) is left in the final solidified lava of example 1 and 2.

18 Based on the foregoing description, the method for using high
19 temperature plasma to treat titanyl phthalocyanine (TiOPc) has the following
20 novel features:

- 21 1. The high temperature plasma can disintegrate the titanyl
22 phthalocyanine (TiOPc) completely, which is a marked improvement over
23 conventional incinerating methods.
- 24 2. The final product of the high temperature plasma is lava, not dust,

1 residue or other toxic materials as found in conventional incinerating furnaces.
2 The lava is chemically very stable in comparison to the dust and residue and does
3 not need to undergo any troublesome subsequent processes.

4 3. The method of using high temperature plasma provide as an easy way
5 to resolve the treatment problem of organic photo-conductor with titanyl
6 phthalocyanine (TiOPc).

7 Even though numerous characteristics and advantages of the present
8 invention have been set forth in the foregoing description, together with details
9 of the function of the invention, the disclosure is illustrative only, and changes
10 may be made in detail, especially in matters of compositions of samples, within
11 the principles of the invention to the full extent indicated by the broad general
12 meaning of the terms in which the appended claims are expressed.